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The discount rate in investment analysis : its determination and application.

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THE DISCOUNT RATE IN INVESTMENT ANALYSIS

ITS DETERMINATION AND APPLICATION

by

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CHAPTER I

INTRODUCTION

The operation of a successful, profit-seeking enterprise requires a series of discussions in four major areas:

What facilities should be acquired?

When should these additional or replacement plant acquisitions be made?

Which product line should be chosen?

How should expenses be controlled?

A wrong decision in any one of these areas can have serious consequences. Mistakes in the first two can easily be fatal; they are the basic make-or-break choices, which offer only one chance.[1] The impact of these decisions is clear when it is realized that:

a. if an error is committed, corrective action can be taken only at considerable loss.

b. future prosperity depends upon growth and the success of new ventures.

c. capital expenditures are strategic.

d. capital expenditures affect shareholders, competitors, employees, management and customers.[2]

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[1]Ray I. Reul, "Profitability Index for Investments," Harvard Business Review (July-August 1957), pp. 116-132.

[2]Geoffrey G. Meredith, Capital Investment Decisions - A Manual for Managerial Planning (Brisbane, Australia: University of Queensland Press, 1966), p. 1.

Thus, probably no other area of decision making is as important to the success of the firm as is that involving capital investment.[1] This is illustrated by the fact that this area is one of the relatively few reserved to the top level of the managerial hierarchy, even in decentralized operations.[2]

At one time it was customary to make capital investment decisions on the basis of experience and intuition. The trend, however, has been toward an objective approach in which investment alternatives are evaluated by means of quantitative methods of analysis.[3] Granted that capital budget decisions based on hunches or partial understanding have often been profitable in the past; but the margin for error is vanishing. Refusal to adopt a sound capital expenditure program or an inability to decide wisely will drive a company into oblivion.[4]

Depending as it does on the successful forecasting of future events, logical analysis alone frequently cannot yield the complete answer to a capital investment problem. But omniscience is not a prerequisite of scientific method. That all the facts relevant to business decisions cannot be known is no justification for abandoning a rational approach or making do with rough and ready rules of thumb, which too often conceal a serious lack of professional competence. Progress in management depends upon the application of logic to experience, to known

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[1]Robert W. Johnson, Financial Management (Boston: Allyn and Bacon, Inc., 1962), p. 174

[2]Meredith, op. cit., p. 1.

[3]Raymond R. Mayer, Financial Analysis of Investment Alternatives (Boston: Allyn and Bacon, 1966), preface.

[4]John A. Griswold, More for Your Capital Dollar (Hanover, N. H.: The Ares Tuck School of Business Administration, Dartmouth College, 1957), p. 1.

or assumed facts in order to enlarge the area of understanding, and investment decisions are no exception.[1]

The exigency delineated above is now generally recognized by businessmen and academians alike and the recent literature abounds with descriptions of, recommendations for, and controversies concerning various analytical methods designed to place the evaluation of investment proposals on a more objective basis. It would appear that the philosophy and techniques of evaluating the worth of investments would have evolved to a unique, proven and universally accepted procedure. Nothing, however, could be further from the truth. The methods in use today are legion, but it is seldom that any two of them yield consistently comparable results.[2] There has, at least in academic writings, arisen general acknowledgement that a viable procedure must take into account all cash flows during the economic life of the project and the time value of money. Acquiescence to these principles has led inexorably to procedures which "discount" the cash flows attributable to the project under consideration. While there is growing accedence to the theoretical and practical validity of these methods, there exists wide dissent regarding the determination of the rate at which the flows should be discounted. This determination is a focal point, for capital investment involves a series of compromises. The investor must strive to strike the proper balance between consumption and investment, between dividends and retained earnings, between debt and equity, and between relatively certain, low-income projects and high-risk projects offering the opportunity for lu-

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[1]A. J. Merrett and Allen Sykes, The Finance and Analysis of Capital Projects (New York: Wiley and Sons, Inc., 1963), p. xiii.

[2]Reul, op. cit., p. 117.

crative returns. Deciding where between these polarized positions to operate comprises the core of investment management, be it for a firm's facilities program or an individual's portfolio.

It is a point central to this presentation that some or all of these decisions may be reflected in the discount rate selected. Shall the rate be based solely on cost of capital or should surcharges be applied to account for considerations such as project risk? How do we account for opportunity costs? These are critical questions for the rate eventually selected establishes not only an accept-or-reject datum but may influence the relative attractiveness of alternate proposals. The importance of the discount rate, then, is that it is one figure which, if reasonably and accurately calculated, can reflect the various forces acting upon the decision-maker and which permits application of a common denominator to the multiple proposals available. It is the aspiration of this paper to pose some questions central to the process of establishing and applying the discount rate utilized in discounted cash-flow methods of evaluating capital investment proposals.

The Research Questions

The basic question to be answered may be stated as follows:

What are the factors which should be considered in the establishment of the discount rate utilized in the discounted cash-flow methods of evaluating capital investment proposals?

Incremental to the principal inquiry are a number of subsidiary questions including:

a. Should the discount rate be based principally on the cost of capital?

b. Should the discount rate include a factor to compensate for risk?

c. Should an identical discount rate be applied to all proposed projects in a given corporation?

d. Should the discount rate remain constant as applied to all cash inflows and outflows throughout the estimated useful life of the project?

e. Should periodic as opposed to continuous discounting be used for all projects?

Limitations

This study is limited to that portion of the capital budgeting process involving the quantitative evaluation of submitted proposals. The requirement for a system which ensures that projects are initiated, considered by the proper management people, implemented and post-audited is well recognized but is beyond the scope of this presentation. Similarly, while aware that if estimates are not adequate, arguments about the fine points of analytical technique are pointless, the process of obtaining estimates is assumed to have been completed.

To facilitate concentration on the central theme and to establish reasonable boundries for the scope of this presentation, a number of other factors will receive relatively transitory consideration. Therefore, while reference will be made to the areas in aggregate, the intricacies and nauances of factors such as inflation, taxes and capital gains considerations will not be addressed.

Organization

Chapter II. describes the objectives of the firm and general cap-

ital investment theory as well as presenting a number of analysis methods prevalent in the literature and in industry. The diversity and characteristics of non-discounting methods and the major discounting methods are described. After delineating the rationale and advantages of the discounting procedures this chapter proceeds with a more detailed comparison of the advantages and disadvantages of the Net Present Value and Yield methods.

The implications of various influences upon the discount rate are then explored in Chapter III. The factors examined include capital structure, cost of capital, risk, cash flows and the various categories of investment proposals, including a differentiation between those which are meant to maintain and those which seek to augment profits.

Chapter IV. is concerned primarily with deriving a means by which the above factors best can be reflected in quantitative terms within the analysis process, in order to present to the decision maker an indication of the value of the proposal. The consequences of accounting for risk and opportunity costs through the discount rate versus other vehicles is discussed, as are considerations of varied and continuous rates. The latter portion of this chapter presents techniques for "smoothing" irregular cash flows and assessing the costs of postponing project implementation.

Chapter V. is a summation of the findings and conclusions of the paper.

Methodology

The methodology utilized in the paper is based primarily upon library research. The principles and factors examined in Chapters II. and III. are available in the plethora of literature directed toward

the sphere of financial management and its component, investment analysis. Upon this foundation an effort is made in Chapter IV to clarify some of the disputes and to develop a framework which will provide to the decision-maker a logical and definitive presentation of the investment alternatives.

CHAPTER II

THE THEORY OF CAPITAL INVESTMENT OBJECTIVES AND METHODS OF ANALYSIS

The Objective of the Firm

Capital investment decisions, by nature, frequently represent a strategic decision for management since to a large degree they affect the future performance of the firm. It is, therefore, inherent that this class of decisions be evaluated in the context of anticipated results relative to the goals toward which the organization is striving. A corporate objective is required in order that these decisions be made on a rational basis. Without an objective, the firm lacks a criterion by which to measure the effect of proposed decisions.[1] Consequently, the conceptual objective of the firm, as discussed in the literature, will be examined to place in perspective the many other facets of investment analysis.

The corporate goal that has been conventionally adopted in discussions of this kind is that the corporation should seek to maximize the economic well-being of present stockholders.[2] From a conceptual stand-

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[1]James T. S. Porterfield, Investment Decisions and Capital Costs (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965), p. 11.

[2]Harold Bierman, Jr. and Seymour Smidt, The Capital Budgeting Decision (New York: Macmillan Company, 1966), p. 151.

point this definition is well and good but obviously for it to acquire any pragmatical significance further discussion is required. Porterfield[1] points out that the goal of maximizing the welfare of the owners is a contentious proposition for many argue that the objectives of the firm should extend to the welfare of others having internal and external connections with the firm and even extend to the broader publics of the community, the general public, and the government. In addition, it is recognized that the managers of publicly owned corporations are in practice somewhat insulated from the multitude of shareholders and frequently tend to pursue policies perpetuating retention and financial and personal aggrandizement at the expense of the common shareholder.

While it is well to recognize these factors, the intent of this study is to examine what the policy of the firm should be, and numerous points can be presented in support of the maximization of wealth criterion:

(1) According to Adam Smith and other classical economists, the firm by pursuing its own interests as avidly as possible is led thereby to promote the general economic welfare. This thesis continues to underlie the philosophy of what we call a free enterprise economic system.

(2) There is frequently a confusion between ends and means in discussing the goals of the business enterprise. In many instances, pursuing the welfare of other publics is a means to the end of maximizing owner's welfare.

(3) Management is responsible to the owners, whose creature it is. Although in practice the connection between ownership and control is often a tenuous one, the management that persistently fails to seek the welfare of the owners is subject to replacement.

(4) Even if the firm should decide to pursue goals other than its owners' welfare, it should at least be concerned with how much this pursuit is costing the owners.

(5) For purposes of both normative theory and operational

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[1]Porterfield, op. cit., p. 12.

> decision-making, a single explicit objective for the firm is vastly superior to an ill-defined complex of goals. Adherence to the latter would render financial decision-making even more difficult than otherwise it is.[1]

It is considered that the arguments cited above provide sufficient bases for adopting the "maximization of owners' wealth" as the preferred objective of the firm. It now becomes necessary to examine the various factors which constitute and determine owners' wealth. This is a critical component of the investment process, for these factors determine the cost of capital to the firm which in turn influences the acceptable rate of return which the firm must realize on capital employed.[2]

In order to evaluate the benefits to a shareholder we must initially evaluate the requirements of the individual. The purpose of economic activity is consumption. The individual's only purpose in investing should be to consume at some later date.[3] In this dichotomy between a preference for delayed as opposed to current consumption lies the determinant for investment versus current consumption and, to a degree, the preference for capital gains and the reemployment of retained earnings rather than current dividends representing disbursement of all profit. Since the existence of the firm depends upon its capability to attract capital from the individual investor, we have additional support for choosing maximization of owner wealth as our objective.

There are at least two elements involved in attracting stockholders. One is the expected cash proceeds the stockholder anticipates

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[1] Ibid, p. 12.

[2] That the cost of capital and the return on investment may be sympathetic is discussed in Chapter III.

[3] Porterfield, op. cit., p. 151

will result from his stock ownership. These proceeds include dividends and capital appreciation. A second element which must be considered is the timing and uncertainties associated with the expected cash flows.[1]

Thus the common stockholder of a publicly-owned company is vitally interested in the market price of his stock. The earnings plowed back will build up the book value of his investment. If those retained earnings are profitably invested in new projects, the company's future earnings should increase. The risk taken by the common stockholder can be compensated for only by potentialities of appreciation through growth of earnings. Management must work to accomplish this end.[2]

In the last analysis, dividends are all that investors as a whole receive from a stock. They may, of course, also reap appreciation (or depreciation) in market value if they sell their shares. However, the selling price is itself assumed to be a function of expected future dividends at the time of sale. Ultimately, the shares will find their way into the hands of an investor who will hold them through the final liquidation of the enterprise. Plainly, all he will receive from the shares is the dividends that will be paid on them. The amount that he will be willing to pay the penultimate holder will depend upon his expectations of the dividends remaining to be paid. This valuation process may be extended backward in a like manner through the chain of owners of the shares.[3]

Thus viewing the stockholders as a whole, not only must the man-

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[1]Bierman and Smidt, op. cit., p. 151.

[2]John F. Childs, Long-Term Financing (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1961), p. 6.

[3]Porterfield, op. cit., p. 19.

agement of a company attempt of produce satisfactory earnings over the long run, but it must also follow financial policies which will produce the best market price for the stock over the long run.[1] It is in this context that decisions regarding the magnitude of dividends and retained earnings must be made. It is evident that the decisions made in this sphere will affect the cost of capital of the firm and directly influence the amounts available for capital investments and the criterion and methods chosen to evaluate investment proposals.[2]

At this juncture we may state that the organizational goal of striking an optimum balance between dividends and market price benefits shareholders individually and collectively. By paying dividends at the times and in the amounts which optimize the sum of market price plus dividends and, conversely, avoiding the payment of dividends when such action would decrease owners' wealth, the firm benefits the collective owners. Such a policy serves the individual shareholder as well, for if the income stream of a particular owner is larger than that required for his optimal pattern of present consumption, he can lend the surplus or otherwise invest it in assets. The owner whose income stream is smaller than that needed for consumption purposes can borrow or sell assets to obtain the needed current funds. If their wealth were not maximized, the owners might not be able to achieve the current consumption patterns optimal to them.[3] Since consumption requirements and preferences of individual shareholders vary widely, this policy has the additional ad-

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[1]Childs, op. cit., p. 6.

[2]The influence of market price on the cost of capital is discussed in Chapter III.

[3]Porterfield, op. cit., p. 64.

vantage of liberating the firm from any requirement to consider the individual preferences of its shareholders. It is axiomatic that since market price is based upon future expected earnings, in order to justify retention, earnings must have an opportunity to generate additional profits equal to or greater than their present value if issued as dividends. While the determination of dividends is obviously peculiar to each corporation, it is considered that the policy described above is conceptually correct and does provide a suitable framework within which the firm may examine its alternatives.

There is one other factor which should be cited and that is consideration of the impact upon market value of a change in dividend policy. Under conditions of uncertainty, the market rate of discount may be affected by the relative predictability of the stream of future dividends expected from the firm. Lacking prescience, the market might feel more certain of future dividends if current payments were maintained.[1] A change in dividend payout undoubtedly disturbs the investors in that stock to some extent unless the modification was anticipated previously.[2] Influenced by this uncertainty, the manager may choose to maintain the recent dividend rather than risk reaction adverse to total owners' wealth.

Capital Investment Analysis Theory

Capital investments are those expenditures that yield prospective earnings for longer or shorter periods in the future beyond that of the year of initial financing, and hence may be "capitalized" in the balance

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[1] Ibid, p. 90.

[2] James E. Walter, "Dividend Policy: Its Influence on the Value of the Enterprise," The Journal of Finance, Vol. XVIII. No. 2 (May 1963), p. 283.

sheet under some subcaption of assets.[1] The two main facets in capital budgeting are provision of a system to insure that proposals are generated, considered, approved and implemented and that the individual proposals are subjected to analytical techniques during the evaluation process.

The analysis segment of the capital budgeting cycle is a principal contributor to sound management, for it is in this phase that individual proposals are screened and dissected so that their strengths and weaknesses are disclosed and presented to the decision-makers who formulate the approved capital budget. In particular, top management needs an objective means of measuring the economic worth of individual investment proposals in order to have a realistic basis for choosing among them and selecting those which will mean the most to the company's long-run prosperity.[2]

Shillinglaw states that some projects, such as a washed out trestle on a key spur, have profitability so great as to rule out analysis while at the opposite extreme some projects are so "blue sky", whose profitability is so diffused and uncertain, that executive judgment will not be greatly improved by rigorous analysis. In between, where the bulk of investment proposals lie, measurement of investment worth is neither unnecessary nor impossible.[3]

While it is considered that the trestle example chosen is more properly characterized as an urgent repair, and while it is considered that no project deserves free admittance into the capital budget, it is

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[1]Ross G. Walker, "The Judgment Factor in Investment Decisions," Harvard Business Review (March-April, 1961), p. 95.

[2]Joel Dean, "Measuring the Productivity of Capital," Harvard Business Review (January-February, 1954), p.

[3]Gordon Shillinglaw, "Measuring the Investment Worth of Investment Proposals," Financial Management Series #105 (American Management Association, 1953) p. 15.

agreed that analysis is required and that techniques available for providing both minimal acceptance levels and ranking by relative attractiveness should be applied. This is true even in those cases where the firm is influenced, by secondary reasons, to select a less profitable alternative. It should be noted that even in these cases a rational decision can be reached only after management identifies the most profitable alternative. Having done this, it can go on to determine the cost of substituting its secondary goals and ascertain whether it can afford to incur this cost.[1]

One of the primary difficulties in capital budgeting is obtain comprehensive and accurate raw data and estimates. With this data in hand, investment decisions may be improved by the use of analytical procedures. The data required includes initial capital outlay and future net incremental positive and negative cash flows.

A number of objective analytical methods have been developed for both screening and ranking purposes. They range from relatively simple to complex and some are better suited to particular purposes than are others. A number of the more common techniques together with comments regarding their advantages and disadvantages shall be presented.

Methods of Analysis

Payback Period

The payback period method is simple, easy to explain, and has been a very popular method of evaluating proposals. It is calculated by dividing the initial outlay by the estimated annual return to find the number of years required to recapture or amortize the original in-

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[1]Mayer, op. cit., p. 1.

vestment. Thus, if the original investment is $9,000 and the return per annum for an indefinite period is estimated as $3,000 then the payback period would be three years. The sums involved can be easily modified to give the payback period subject to profit after tax or before tax, plus depreciation charges and other measures.

Although this method enjoys widespread popularity due to its simplicity it has at least three major weaknesses.

a. Since it gives equal weight to equal amounts returned in different periods it takes no cognizance of the concept of the time value of money. This concept holds that a dollar today is worth more than a dollar a year from now, basically because the dollar in hand today could be earning interest during the coming year. This concept of the time value of money, or present worth, will be examined more fully later in this chapter. For the case in point, it validly holds that the $3,000 return in year number three is worth something less than the $3,000 return of the first year and that the calculated payback period of three years has therefore been somewhat distorted.

b. It ignores the existence of any returns occuring after the expiration of the payback period itself.[1] Again returning to our example, according to the payback method an investor would be indifferent between a project with an initial outlay of $9,000 and a per annum return of $3,000 for three years and a project with an initial outlay of $9,000 and a per annum return of $3,000 for five years. The method thus fails to disclose some important facets of the alternatives.

c. The payback period chosen as a datum for acceptance is an end in itself and cannot be related to the firm's assumed objective of

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[1] Porterfield, op. cit., p. 21.

maximizing the wealth of its owners.

The above weaknesses discredit the payback period method as a valid technique for ranking the relative profitability of proposed investments. It may, however, enjoy some merit if used merely as an approximation of the period required to recapture expended funds and perhaps as an indication of the influence of uncertain life span upon overall project risk.

Proceeds per Dollar of Outlay

In this method the investments are ranked according to an index achieved by dividing the total returns by the amount invested in the project. Although the alternatives may be ranked by the indices provided, once again the failure to take cognizance of the incremental timing of the returns voids the validity of the comparisions.

Average Annual Proceeds Per Dollar of Outlay

The first step taken in this method is the division of total estimated proceeds by the time span, in years, over which they are expected to accrue. The figure computed is the average proceeds per year and this figure is then divided by the original outlay required by the project.

This procedure is an oddity, and its prime weakness is enough to disqualify it from further consideration. By failing to take properly into consideration the duration of the proceeds it has a bias for short lived investments with high cash proceeds.[1] This weakness is particularly dangerous because it appears to consider the time period and this lack of disclosure may be misleading to the decision-maker. In summary, the method combines the disadvantages of the payback method and the proceeds per dollar of outlay method and should not be used.

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[1]Bierman and Smidt, op. cit., p. 23

Average Income on the Book Value of the Investment

Once again a ratio is used in an attempt to measure the efficiency or return on investment. The following ratio is used:

$$\frac{\text{Average income - depreciation}}{\text{Book Value of the Investment}}$$

This ratio is a common and useful measure of performance. However, since it also fails to take cognizance of the timing of income increments it is less useful as a means for providing preferential rankings of alternative investments.

An alternative procedure is to divide income by the cost of the investment (accumulated depreciation not being subtracted). For purposes of measuring performance and computing return on investment, the use of undepreciated cost has certain advantages over the use of book value. These advantages are not so important in capital budgeting and are relatively unimportant compared to the failure to take into consideration the timing of the cash proceeds.[1] Another factor neglected is the gestation or pre-production period between the commencement of a project and the time when it begins to produce an income.[2] In summary, this technique is far more useful as an evaluation device in a dynamic situation than in pre-evaluation of proposals.

Prior to examining some of the methods which recognize the timing of expenditures and returns it is appropriate to discuss the concept of the time value of money in greater detail. We have seen that the primary defect of the analysis methods just discussed was their failure to be cognizant of this concept.

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[1] Ibid, p. 25.

[2] Merrett and Sykes, op. cit., p. 221.

It seems apparent that, unlike Gertrude Stein's, "A Rose is a Rose is a Rose," a dollar is not a dollar without regard to a number of its fellows.[1] A dollar received today is generally worth more to us than a dollar to be received in one year or in ten years, even if we assume no price inflation. This is because we can either consume the dollar now with more satisfaction than later or invest it so as to receive more than one dollar in the future. Of course this assumes positive rates of interest and time preference.[2]

With these assumptions in force we may derive a function which will express the future value at time, n, of the present dollar.

Let: P_o, P_1, P_n = Principal at times o, 1, n.
r = rate of compound interest

$$P_1 = P_o + r P_o$$
$$= P_o (1 + r)$$
$$P_2 = P_o (1 + r) + r P_o (1 + r)$$
$$= P_o (1 + r) (1 + r)$$
$$= P_o (1 + r)^2$$

Then : $P_n = P_o (1 + r)^2$

In this case the principal is discreet since the time periods are discreet, i.e., n, is expressed in periods and the function could not correctly be plotted as a series of connected points. However, expressions can be derived for reduced periods and for continuous periods and tables representing all of these situations have been calculated and are available for application.

Re-expressing our function for discreet periods:

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[1]Donald E. Farrar, The Investment Decision Under Uncertainty (Englewood Cliffs, N. J., Prentice-Hall Inc., 1962), p. 11.

[2]Porterfield, op. cit., p. 22.

$$C = \sum_{i=1}^{i=n} \frac{A_j}{(1 + r)^i}$$

Where: C = the investment cost.

A_j = the net proceeds for each succeeding year.

r = the discount rate

i = year 1, year 2, ... year n.

or: The present value of a future sum is equal to the amount of that future sum divided by $(1 + r)^i$.

Thus we may calculate the present value of any future receipt or disbursement. The aggregate present value of a series of future cash flows is the algebraic sum of the present values of the individual receipts and disbursements.

The function expressed is valid only if the effective interest or discount rate remains constant throughout the period under consideration. If the interest rate is assumed to change, the present value must be computed in two or more steps. That is, the future sum would be discounted back at one interest rate to the time when the discount rate is assumed to change. Then, the value at that time would be discounted at the next interest rate, and so on.[1] It is evident that the procedures for and the accuracy of the cash flows, positive and negative, are of particular significance in the application of this concept and therefore both the procedures and the treatment of uncertainties inherent in the estimation of future cash flows will receive more thorough examination in latter portions of this paper. The above description of the principle involved is sufficient to allow us to proceed to a discussion of methods

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[1] Ibid, p. 24.

of analysis which incorporate the time value of money concept.

The Net Present Value Method

This measure is a direct application of the present-value function. Its computation involves the following steps:

(1) Select the discount rate.[1]

(2) Estimate the differential cash inflows, or "earnings", for each year or sequence of years including:

a. The cash earnings, neglecting depreciation, after taxes for each year of the economic life.

b. The depreciation tax shield as applicable.

c. Residual values at the end of the economic life recognizing that these may be positive in the event of salvage value or release of working capital or negative in the event that disassembly and/or disposal costs are involved.

(3) Estimate the cash outflows to include initial outlays as well as any future cash outlays for the year in which they will occur.

(4) Find the net present value of all inflows and outflows by discounting them at the required earnings rate.

If the present value of inflows exceeds the present value of outflows then, aside from nonmonetary factors, the indication is that the investment proposal is acceptable. The magnitude of the net present value is an indication of the relative worth of the project. An additional advantage is that present value compensates to some extent for the decreasing reliability in forecasted cash flows because it assigns significantly lower present values to flows that are expected to occur in the

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[1]See Chapter IV. for a discussion regarding the selection of the discount rate.

more distant future years.[1] Thus the margin of error in forcasted cash flows generally increases as forecasts stretch further into the future. One case where this compensation is not effective is when the project involves a large uncertain initial investment such as the construction of a new nuclear power plant. The discount method also gives us the flexibility to reflect depreciation and taxes where and when we want to under existing rules.[2]

The Yield or Rate of Return Method

This method involves finding that discount rate which equates the present value of the cash inflows to that of the cash outflows. It is most simply defined as that compound interest rate which equates the total present worth of a project to zero.[3] As such, it is the maximum rate of interest which could be paid for the capital employed over the life of the investment without incurring a loss on the project.[4] Quantitatively, it is found by solving for r in the following equation:

$$C = \sum_{i=1}^{i=n} \frac{A_i}{(1+r)^i}$$

where the symbols are as previously defined.

Owing to the lengthy equations involved, the discount rate is frequently determined by trial and error. An alternate approach involves charting various discount rates vs. the resultant present values.[5] The

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[1]National Association of Accountants, Research Report # 35 (December, 1959), p. 64.

[2]Griswold, op. cit., p. 5.

[3]Tahmasp Khan Anwar, Cost Benefit Analysis (Lahore, Pakistan: National Institute of Public Administration, 1965), p. 75.

[4]National Association of Accountants, Research Report # 35 (December, 1959), p. 57.

[5]Reul, op. cit., p. 118

rate of return method is conceptually equivalent to the present value method. One advantage sometimes ascribed to it is that it voids the requirement for preselection of a discount rate while still permitting the ranking of projects relative to a datum rate.

However, it suffers from a number of limitations arising from its method of calculation and the assumptions implicit therein.[1] Some projects may have more than one rate of return. That is, there may be more than one discount rate that equates the streams of cash inflows and cash outflows. The following examples demonstrate this difficulty:

TABLE 1

HYPOTHETICAL INVESTMENT PROPOSALS

	Project A.		Project B.	
Time	Cash In	Cash Out	Cash In	Cash Out
t_o	0	1	0	1
t_1	6	0	2	0
t_2	0	6	0	2

Source: Porterfield, op. cit., p. 25.

In Project A two values of r satisfy the equating of cash inflows to cash outflows, minus 27% and plus 373%.

In Project B the solution reduces to:

$$r^2 = -1$$

and therefore there is no real number which satisfies the basic equation.

While much attention is given to this type of disparity in the literature, it is not considered to be a major weakness. Projects with either multiple rates or no real rates of return are probably relatively

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[1]Porterfield, op. cit., p. 25.

rare. They result from unusual patterns of cash flows wherein net cash outflows will be reflected in certain future periods.[1] As such, they are considered to be readily recognizable as exceptional cases and can be treated accordingly. Some assumptions, notably that intermediate cash inflows will be reinvested at a rate of return equal to that assigned to the initial investment, have also been criticized. However, this assumption usually is made for all discount methods although it is more easily accounted for in the net present value method. This point, as well as others, will be discussed in more detail in the section which compares the relative merits of the yield and present value methods.

The Annual Capital Charge Method

Whenever a capital investment is made which gives rise to a constant (or approximately constant) net cash flow it is possible to make use of the capital charge method.[2] This method also recognizes both the interest and "retirement" costs associated with the use of capital. Therefore, its aim is to ascertain whether the net cash flow is sufficient to cover the depreciation of the capital and the minimum carrying costs. We have seen that the present value approach accomplishes this purpose by comparing the present value of cash inflows to cash outflows. The yield method consists of determining that discount rate which equates the net present value to zero. The annual capital charge method achieves the same result by calculating the average annual charge (depreciation plus interest) and comparing this with the annual constant net cash flow.[3] If the

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[1]Porterfield, op. cit., p. 26.

[2]Converting irregular cash flows into annual constant equivalents makes possible the use of this method under varying flow circumstances.

[3]Merrett and Sykes, op. cit., p. 39.

net cash flow exceeds the capital charge then the project is acceptable. The essentially different feature of the annual charge method is its use of a sinking fund method of depreciation. This probably derives from the fact that the enterprises using it typically are largely, if not entirely, financed by debt capital and often make formal provision for the redemption of capital via sinking funds.[1]

Profitability Index

The profitability index is a ratio of the present value of cash inflows divided by the present value of the cash outflows. It has been attacked because of the difficulty of distinguishing between investment and expense type outlays; for example, when is advertising a deduction from proceeds or an addition to investment?[2] However, it is considered that these decisions, difficult though they may be, are and must be made. Once policy is established and decisions made accordingly this index has considerable value in the analysis process.

The criteria for selecting a correct method are that it should:

(1) Include all cash flows.

(2) Recognize the time value of money.

(3) Discount all flows.[3]

From these criteria it is obvious that, of those methods discussed only the yield, present value, and annual capital charge methods are

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[1] Ibid, p. 40.

[2] Bierman and Smidt, op. cit., p. 49.

[3] George A. Christy, Capital Budgeting - Current Practices and Their Efficiency (Eugene, Ore.: Bureau of Business and Economic Research, University of Oregon, 1966), p. 61.

correct. Discussion of discounting's difficulty is almost irrelevant because there is no easier way accurately to determine a project's rate of return.[1] No further discussion will ensue regarding the annual capital charge method since this method, excepting complicated equivalents conversions, is practical only in those situations involving constant annual cash flows.

The rate of return and net present value methods are consistent with the assumed objective of the firm, the maximization of the value of its shares. They measure proposed investments in terms of time-adjusted cash flows. Thus, these methods of measurement are consistent with the goal.[2] Having reduced the field of consideration it is possible to proceed to discuss the relative merits of the present value and yield methods.

Net Present Value versus Yield

It has been seen that neither the yield nor present value procedures can be eliminated as being obviously incorrect. As a matter of fact, the literature is divided regarding preference for one or the other of the two methods. For instance, Bierman and Smidt strongly favor present value while Merrett and Sykes argue for yield.

The most obvious difference is the application of the required rate. A pre-determination of the minimum rate must be made before present value calculations are performed. In the yield method the calculated "equalizing" rate is compared to some rate chosen as the acceptable stand-

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[1]Griswold, op. cit., p. 2.

[2]Porterfield, op. cit., p. 32.

ard. Thus, while it is technically correct to state that the yield method avoids the requirement for a predetermined rate, it is equally true that the calculations have no utility until such a determination is made. Hence, the only difference in this regard, whatever the basis for choosing the rate, lies solely in the timing of the application.

In certain circumstances it is necessary to rank projects that are "mutually exclusive". That is, by their nature the selection of one alternative rules out the accomplishment of the other alternative. An example would be different uses of a particular parcel of land or the choice between a four or six inch size for a pipeline. The need for ranking also arises under conditions of capital rationing and, it should be noted that, in practice, one of these conditions will almost certainly prevail. Capital rationing means that owing either to a policy adopted by management or to limitations enforced by the capital markets, the firm does not have access to unlimited funds with which to undertake acceptable projects. In this situation, it is often necessary to rank proposed investments so that the limited funds available may be allocated among competing projects to the firm's best advantage.[1] Because the selection, once made, eliminates the remaining alternative(s) a deficiency of either method in this area would be very serious. It is worthy of note that both Bierman and Smidt[2] and Merrett and Sykes[3] agree that in such cases the present value method is superior because of its consideration of incremental rather than average cash flow.

For accept or reject screening of a proposal both procedures

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[1] Ibid, p. 33.

[2] Bierman and Smidt, op. cit., p. 41.

[3] Merrett and Sykes, op. cit., p. 152.

will give the same indication under conditions of a "normal" pattern of cash flows. A "normal" pattern refers to an initial cash outflow followed by a series of subsequent cash inflows only.

Previous reference was made to the possible difficulty that no real rate or no single rate may be calculated by the yield method under certain unconventional flow patterns. However, analysis of normal patterns by either method provides an identical accept or reject decision as proven algebraically by Porterfield:[1]

Let: r = rate of return.

d = discount rate.

O_o = cash outflow at time o.

I_1, I_2, I_n = cash inflows at times 1, 2, n.

Then,

$$\frac{I_1}{(1 + r)} + \frac{I_2}{(1 + r)^2} + \ldots + \frac{I_n}{(1 + r)^n} = O_o$$

And, assuming net present value to be positive,

$$\frac{I_1}{(1 + d)} \quad \frac{I_2}{(1 + d)^2} + \ldots + \frac{I_n}{(1 + d)^n} > O_o$$

The question at hand is, could $r < d$, a rejection signal under the yield method?

Let: $$\sum_{i=1}^{i=n} \frac{A_i}{(1 + r)^i} = X$$

Let: $$\sum_{i=1}^{i=n} \frac{A_i}{(1 + d)^i} = Y$$

$$X = O_o, \text{ and}$$
$$Y > O_o$$

However, since if $r < d$, X would be greater than Y. Since this

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[1]Porterfield, op. cit., pp. 33-34.

is impossible because $Y > 0_o$ and $X = 0_o$ the two methods must give the same accept or reject indication.

The major arguments in favor of yield method cite the greater familiarity of businessmen with a "return" concept and its ranking of competitive, that is, non-mutually exclusive projects. Exception can be taken to the former point since a board reviewing projects presented in present value format would certainly be, or quickly become, familiar with its indications and implications. The latter point is deserving of further examination and is illustrated by the following example:

TABLE 2

A COMPARISON OF INVESTMENT ANALYSIS BY THE YIELD AND NET PRESENT VALUE METHODS

Time	t_o	t_1	t_2	t_3
Project A				
Cash in	-	100	500	1,500
Cash out	1,000	-	-	-
Project B				
Cash in	-	600	600	600
Cash out	1,000	-	-	-

Source: Porterfield, op. cit., p. 36.

The analysis results are:

	Yield	NPV (at 5%)
Project A	32%	$845
Project B	36%	$634

Therefore, Project A is favored by the present value method and Project B is favored by the yield method. It has been said that the yield method will produce a correct sequence irregardless of the standard acceptance rate chosen whereas, in the present value method, an error

in the choice of discount rate adversely influences all subsequent calculations.

Table 3 illustrates how varying the discount rate may affect the net present value of different cash inflows:

TABLE 3

HYPOTHETICAL CASH FLOWS

Project	t_o	t_1	t_2
A	120	120	120
B	0	190	190
C	0	0	398
D	330	0	0
E	172	172	0
F	180	0	180

Using a discount rate of 10%, the net present value of cash inflows is identical, $300, for all projects. The application of a different rate would result in different net present values for the various projects.

More basic, perhaps is the inherent dependence of both procedures upon the rate at which it is assumed intermediate cash inflows can be reinvested. In the example, the high reinvestment rate assumed in the yield method favors the larger intermediate inflows of Project B while these same inflows, discounted at only 5% under the present value approach, handicap Project B. It should be noted that the present value method is more easily adjusted to take into account reinvestments of cash inflows at varying rates.[1]

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[1]Porterfield, op. cit., suggests a net terminal value method which combines the cash flows of the investment with those of its source of financing. This writer considers that NPV utilizing adjusted rates is a practical alternative.

Even if no reinvestment opportunities are involved the two methods may indicate different preferences if the initial outlays are different.

For example:

TABLE 4

A COMPARISON OF INVESTMENT ALTERNATIVES; MAXIMIZING DOLLAR OR PERCENTAGE RETURN

Time	t_o	t_1
Project A		
Cash in	-	150
Cash out	100	-
Project B		
Cash in	-	1,200
Cash out	1,000	-

Source: Porterfield, op. cit., p. 37.

The analysis rates are:

	Yield	NPV
Project A	50%	$36
Project B	20%	$91

The optimal investment in this case depends upon whether the firm wants to maximize the dollar return on its investment or whether, because of capital rationing, it would prefer to take advantage of a smaller but "richer" opportunity.[1] The above discussion would indicate that the net present value approach is advantageous in situations involving mutually-exclusive proposals whereas the yield method provides superior indications when capital rationing exists.

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[1]Ibid, p. 37.

If, for purposes of comparability and uniformity, the firm desires to utilize only one discount approach the present value method is recommended because of its broader applicability and flexibility.

CHAPTER III

FACTORS INFLUENCING THE EVALUATION OF CAPITAL INVESTMENT PROPOSALS

Capital Structure

Capital structure includes all long-term obligations and equity, that is, any item of permanent capital. Debt may take such forms as mortgage bonds, debentures or long-term notes. One of the features which distinguishes debt from equity is that it carries an obligation to pay principal and interest. The default of this obligation can place the company in bankruptcy.[1] A company financed only with funds obtained from stockholders may eventually have to cease operations because of a combination of operating losses and poor investments has exhausted its funds, but shareholders are not exposed to the risk of bankruptcy unless debt is acquired. With debt it is possible equity holders may lose their interest in a company that may again become a profitable operation. In practice, the legal possibility of bankruptcy is nearly always present, since a company will always have at least some accounts payable outstanding. However, as the amount of debt rises, the risks of bankruptcy become greater, until the point is reached where the risk is substantial.[2]

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[1]Childs, op. cit., p. 8.

[2]Bierman and Smidt, op. cit., p. 167.

The utilization of debt capital is another instance of managers, and investors, making a trade-off between risk and the monetary gains available.

The object of raising debt capital is basically to provide finance on terms cheaper than those required by the equity shareholders. Essentially the firm is selling a certain proportion of its income as a prior charge to the debt holders in return for a capital sum.[1] This use of nonequity capital to increase the rate earned on equity is known as leverage. For example, with one hundred dollars of equity capital and the opportunity to earn a ten percent return on the investment, net income will be ten dollars and ten percent has been earned on equity. However, if an additional hundred dollars is borrowed at five percent interest, net income is twenty dollars less the five dollar cost of debt capital and the return on equity has been increased from ten to fifteen percent.

Under present conditions there are two additional advantages involved in the employment of debt. There may be significant benefits available within the tax structure since all or a portion of the interest may be tax deductible. Additionally, during periods of inflation the real income available to the equity shareholders increases as the burden of servicing debt capital falls. During prolonged inflation either the rate of interest on new debt rises to compensate for the expected rise of inflation, or the supply of debt capital contracts. Usually both these outcomes will occur simultaneously. But this does not prevent firms with debt capital from benefiting substantially until these changes occur, which is typically a long time.[2]

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[1]Merrett and Sykes, op. cit., p. 393.

[2]Ibid, p. 409.

Having described the principal advantage and disadvantage of the use of debt capital, the crux of the matter shall now be addressed; what is the proper proportion of equity and nonequity capital, i.e. what constitutes the firm's optimal capital structure? Childs refers to the "division of the pie" between debt and equity as probably the most important financial decision to be made by the management of a company.[1] It has been suggested that the weighted average cost of capital to a company is not greatly affected by the company's capital structure because individual investors are free to increase or decrease the degree of leverage in their own portfolios.[2]

The traditionalist view holds that if, for a firm with more than the conventional acceptable proportion of debt capital, the proportion of debt capital was further increased, the combined market value of that firm's debt and equity would tend to be constant or even fall. Put another way, when the debt becomes "excessive" the income of the debenture holders and possibly the equity investor is held to be at such risk that the combined value of the debentures and the equity shares would tend either to remain constant or actually fall. The traditional position argues that at lower levels of debt stockholders would be willing to accept greater risk in return for higher expected dividends made possible by increasing the proportion of debt to equity in the firm's capitalization: at higher levels of debt the expected dividends would not offset the greater risk created by the substitution of debt for equity.[3]

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[1]Childs, op. cit., p. 10.

[2]See F. Modigliani and M. H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review, XLVII (June, 1958), pp. 261-297, for a presentation of this highly controversial theory.

[3]Alexander A. Robichek and Stewart C. Myers, Optimal Financing Decisions (Englewood Cliffs, N. J.: Prentice Hall, 1965), p. 32.

To restate the case, the traditional view on the question of capital structure holds that the value per share can be increased by the judicious use of debt. The argument advanced by Modigliani and Miller implies that the value of a firm is a function of its expected annual income and its cost of capital but is independent of the proportion of debt to total capitalization. The essence of the Modigliani and Miller argument is that arbitrage processes of the individual investors will establish a market equilibrium in which the total value of a firm will depend only on investor's estimates of the firms business risk and its expected future income. The general condition for this equilibrium to exist is that no two claims to expected future cash receipts considered to be identical in risk can sell at prices such that the expected rates of return on the claims differ.[1] It is on this position that the validity of their argument rests and it is this proposition which draws the majority of fire of their critics.

No broader presentation or deeper analysis of the assumptions, limitations or mechanics of the opposing views is required for the purposes of this study. In any event, perhaps ironically, both the Modigliani and Miller and the traditional positions seem to point to the same conclusion: that there is some degree of leverage which will maximize the value of the firm.[2] The above discussion demonstrates not only the magnitude of the problem which faces the financial manager in the design of the firm's capital structure but also the importance of the decision as it will affect the firm's cost of capital.

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[1] Ibid, p. 25.

[2] Ibid, p. 47.

Cost of Capital

The most commonly used rate of discount in business decision making currently is the cost of capital of the firm.[1] This figure is determined by a number of complex factors.[2] In order to obtain a better insight into the identification and evaluation of these factors we shall examine the qualitative considerations and then present some of the quantitative methods for calculating the firm's cost of capital.

We have said that the cost of capital is composed of several elements. One of these we shall term the explicit cost of capital. The explicit cost of any source of capital is the discount rate that equates the present value of the cash inflows that are incremental to the taking of the financing opportunity with the present value of its incremental cash outflows. This is the same as the discount rate that makes the present value of all of the future cash flows associated with the source equal to the initial inflow that it provides.[3]

If: c = explicit cost of capital
$I_0, I_1, I_2, I_n,$ = cash inflows at times 0, 1, 2, n
$O_0, O_1, O_2, O_n,$ = cash outflows at times 0, 1, 2, n

Then,
$$I_0 + \frac{I_1}{(1+C)} + \frac{I_2}{(1+C)^2} + \ldots + \frac{I_n}{(1+C)^n} =$$
$$O_0 + \frac{O_1}{(1+C)} + \frac{O_2}{(1+C)^2} + \ldots + \frac{O_n}{(1+C)^n}$$

and it is evident from these definitions and from the formula that the explicit cost of capital is nothing more than the "rate of return" of the cash flows of the financing opportunity.[4]

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[1]Bierman and Smidt, op. cit., p. 141.

[2]Merrett and Sykes, op. cit., p. 58.

[3]Porterfield, op. cit., p. 45.

[4]Ibid, p. 46.

The other major element to be considered in examining the cost of capital is implicit costs. While explicit costs are pertinent whenever the firm raises funds, implicit costs arise whenever funds are invested or otherwise used. This is due to the fact that alternative uses are available for the funds in question. For example, if the firm chooses for reasons exogenous to maximizing return on a specific project, to invest in a project having a 15 percent return on investment rather than in a project having a 20 percent return on investment there has been incurred an implicit or foregone profit of 5 percent. This additional five percent "opportunity cost" is the implicit cost of this particular use of capital.

It may be argued that the explicit costs to the firm are at least partially composed of implicit costs to the individual investor or that, conversely, although implicit costs to the investor contribute at least in part to the establishment of the market rate, this consideration is irrelevant for the purposes of this study since the individual investor is free to trade in the open market. The latter approach contends that implicit costs to the firm, while they must be taken into consideration when evaluating investment alternatives, arise only when the funds are invested or used.

This contention fails to take into account the reality that market price rather than dividend costs determine the cost of capital to the firm in all but liquidation transactions. When a firm enters the capital market the decision of the individual investor is based primarily upon the price-earnings ratio he is willing to pay as opposed to the short-term dividends he may forecast. The cost of capital for a firm going to the market is therefore the reciprocal of the price-earnings ratio. For

example, if the earnings are five dollars per share and the individual investor is willing to pay fifty dollars per share for an issue of stock then the firm's cost of capital is 1/10 or ten percent regardless of the current dividend being paid. The fact that it may be more difficult for the firm to predict its cost of capital based on this dynamic basis does not detract from its conceptual and practical advantages over the static approach of a cost of capital based upon dividend policy. Both approaches to determining a firm's cost of equity capital are discussed later in this chapter.

Calculation of the firm's cost of capital would be a relatively simple procedure if all capital had been obtained by the sale of common equity. As we have seen, however, it is very probable that the firm's capital structure is composed of various types of securities. In these circumstances cost of capital is the over-all composite net rate to the company, after allowing for underwriters' compensation and expenses of financing.

A vigorous treatment of the determination of the cost of capital is beyond the purview of this study since the intent of this portion of the discussion is merely to demonstrate the influence of cost of capital upon the discount rate eventually selected for use in investment analysis. However, reference shall be made to a general procedure which may be followed with respect to the two major sources of capital, long-term debt and common equity.

Since the costs must be ascertained on a composite, predicted, average basis, it becomes necessary for the firm to determine which period should be used in establishing the rates. Although historical figures may provide some evidence as to the cost of capital and may even affect

the determination in the case of carry-over obligations, the firm must orient its predictions toward the period in which capital will be obtained and serviced for the investments under consideration. The current "spot" cost is likewise of little value beyond the extent to which it should logically influence the prediction. Childs suggests a five or ten year "rolling average" to obtain a figure unbiased by variations during the business cycle.[1] However, it is considered by this writer that predictions based on techniques such as time series analysis tempered by economic and financial forecasting would be of greater value.

Bierman and Smidt propose that the cost of long-term debt may be estimated as the effective interest rate of the firms long-term debts. This can be calculated by finding the rate of interest which equates the market price of a bond and the present value of the amount due at maturity plus the present value of the series of interest payments. Using dividends as a determiner they suggest also that the cost of common equity amy be estimated by the formula:[2]

$$r = \frac{D}{P} + g$$

where r = cost of capital
D = current cash dividend rate
P = current market price per share
g = expected annual percentage rate of increase of future dividends expressed as a decimal.

Thus with: (1) the market value of a company's common stock estimated at $60 million and the market value of its long-term debt estimated at $15 million

(2) an effective net interest rate of 3 percent on debt

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[1]Childs, op. cit., p. 328.

[2]Bierman and Smidt, op. cit., p. 145.

(3) $D = \$10$
$P = \$100$
$g = .05$

$$r = \frac{10}{100} + .05 = .10 + .05 = 15\%$$

Returning to the dynamic approach it is considered by this writer that calculations of the cost of equity based upon the reciprocal of the price earnings ratio are more relevant. In this area also it is considered that the use of time series analyses tempered by financial forecasting is germane.

The average cost of capital can be estimated as follows:

TABLE 5

CALCULATION OF THE COMPOSITE COST OF CAPITAL

Security	% of Total Capital	Cost	Weighted Cost
Equity	.80	.15	.120
Debt	.20	.03	.006

Estimated Average Cost of Capital 12.6%

The three percent cost of debt capital used above is the post-tax cost. Taxes weigh heavily in financing decisions and their influence on the cost of capital must be given due consideration. For instance it must be realized that in a fifty percent tax structure the after tax cost of a six percent bond is only three percent because interest is a tax deductible item. In contrast, a six percent cash dividend on stock costs exactly six percent since dividends are not tax deductible. It can thus be understood why a firm with an appropriate capital structure may choose validly to retire a five percent preferred stock issue by borrowing at an interest rate such as six percent.

Whatever the method employed, the figures selected, while reflecting the data at hand must be tempered by the judgment of the finan-

cial manager for such is the nature of dealing with future events. The service on debt may be objectively determined if those funds have already been arranged for; the service on equity is inevitably a subjective figure.[1] The determination of these figures is obviously a difficult task. All of these difficulties in no way suggest that a company abandon the problem of determining an approximation of its cost of capital. It can and must be done.[2]

Risk

Risk is the constant companion of wealth. It is the one stern reality which each investor must face.[3]

If we could always assign to an investment a unique set of cash flows, in the absence of capital rationing it would be possible to use relatively simple, straightforward rules for making investment decisions that maximize the well-being of the stockholders in a firm. In practice, businessmen are seldom, if ever, certain of the cash flows likely to result from a particular investment. The existence of uncertainty complicates the job of the investment decision maker, and makes it difficult to offer the decision maker simple decision rules.[4]

Some methods designed to aid in the evaluation of investment alternatives under conditions of uncertainty have been advanced and shall be examined. The various situations which may exist, such as different levels of demand for a product, are known as states of nature.

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[1]This point is made by Donald F. Istvan, Capital Expenditure Decisions - How They Are Made in Large Corporations (Bureau of Business Research, Indiana University, 1961), p. 56.

[2]Childs, op. cit., p. 324.

[3]Dodge and Cox, The Problem of Risk in the Management of Capital (San Francisco: Dodge and Cox, 1936), p. 3.

[4]Bierman and Smidt, op. cit., p. 283.

In any situation in which the state of nature cannot be determined with certainty, and where the results will vary dependent upon the actual state of nature, it becomes necessary to assign a probability to the existence of each possible state of nature. If this estimate of the frequency of predicted occurrence is based upon definitive historical information, objective evidence or rigorous analysis the probability assigned is an objective probability. If, on the other hand, personal experience and intuition are the basis for the assignment, a subjective probability has been applied. For business decision-making purposes the subjective interpretation is frequently required, since reliable objective evidence is not available.[1]

Expected Monetary Value

Expected monetary value, (EMV), is the weighted average of the possible outcomes of a present decision and their respective probabilities. The monetary value of each possible outcome is multiplied by its assigned probability. The sum of these products is the EMV of the spectrum of possible outcomes.[2]

The EMV technique permits the decision-maker to select that action which, in the long run, will result in the maximization of profit, given the probabilities of occurrence of the various possible states of nature and the payoff matrix relating his various action alternatives to those states of nature.

To demonstrate this technique consider the following problem:[3]

a. The cost of a product unit is $6.00 with no salvage value

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[1]Porterfield, op. cit., p. 111.

[2]Harold Bierman, Jr., Charles P. Bonini, Lawrence E. Fouraker and Robert K. Jaedicke, Quantitative Analysis for Business Decisions (Homewood, Illinois: Irwin Co. 1965), p. 13.

[3]This problem is taken from Problem 3-1, Bierman, Bonini, et. al. op. cit., p. 51

if the unit is not sold.

b. Profit on each unit sold is $5.00.

c. The following probabilities are assigned to various demands (states of nature) which may be encountered:

Demand	Probability
10 Units	.10
11 Units	.70
12 Units	.20
	1.00

The manager must decide whether to stock ten, eleven, or twelve units in order to maximize profit.

As the first step in obtaining the EMV a payoff table is constructed as follows:

TABLE 6

CONDITIONAL PROFITS UNDER UNCERTAINTY

		Supply		
Demand	Probability	10	11	12
10	.10	50	44	38
11	.70	50	55	49
12	.20	50	55	60

If our probability distribution is correct we may calculate the EMV of stocking eleven units as follows:

$(.10)(44) + (.70)(55) + (.20)(55) = \$53.90$

Similarly, by applying the probabilities to the various payoffs we calculate an expected profit of $50.00 if we stock ten units and $50.10 if we stock twelve units. This technique has therefore provided the manager with data indicating that stocking of eleven units will maximize his

profit in the long run if the probability distribution for demand is valid.

If the manager were operating under conditions of certainty he could alter his stock level for each period to match the known demand.[1] For this case the payoff matrix under certainty is as follows:

TABLE 7

CONDITIONAL PROFITS UNDER CERTAINTY

Demand	% of time occuring	Supply 10	11	12	
10	.10	50	-	-	5.00
11	.70	-	55	-	38.50
12	.20	-	-	60	12.00
					$55.50

Thus under conditions of certainty the profit would be $55.50. Since the difference between $55.50 under conditions of certainty and $53.90 under conditions of uncertainty equals $1.60, the value of perfect information equals $1.60. This figure represents the limiting amount which should be spent to obtain additional information regarding the demand for the project.

EMV can be a valuable management tool but it can also prove to be deceptive and dangerous. Consider the following situation:

TABLE 8

OUTCOMES OF A HYPOTHETICAL GAME OF CHANCE

Outcome	Probability	Payoff	EMV
Success	.55	+1000	550
Failure	.45	-1000	-450
			+100

[1]Certainty in this instance indicates that the demand will vary (e.g. 11 units will be the true demand exactly 70% of the time) and the manager knows in advance when the various levels of demand will occur and can order accordingly.

According to the EMV method we would undertake the project since it has a positive EMV. However, it is evident that risk has not been considered for it is possible that the firm simply cannot afford to sustain a $1,000 loss no matter how favorable the odds.

Utility Theory

Rational people will sometimes prefer some alternative to the course of action with the highest expected value. Utility theory provides an approach which attempts to describe behavior and preferences in risk situations.

According to the theory, each individual has a measurable preference among various choices available in risk situations.[1] This preference is called his utility and is measured in arbitrary units called "utiles".

How is the utility function relating utiles to monetary values determined? The basic principle to use is this: if a decision maker is indifferent between two alternatives the expected utility of the alternative is the same.[2] The following will provide an example of the application of this principle.

A game is arranged with the maximum loss set at -$1,000 and the maximum gain at +$1,000. Also, arbitrary values of 100 utiles for maximum gain and 0 utiles for maximum loss have been assigned. Questions are then posed to the person whose utility function is being determined. For example, there may be a 90 percent chance of winning $1,000 and a 10 percent chance of losing $1,000. The person may either play the game or receive some amount of cash. At what amount of cash is the player indifferent to receiving the cash and playing the game? If the player selects

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[1]Ralph O. Swalm, "Utility Theory - Insights Into Risk Taking" The Harvard Business Review (November-December, 1966) p. 124.

[2]Ibid, p. 125.

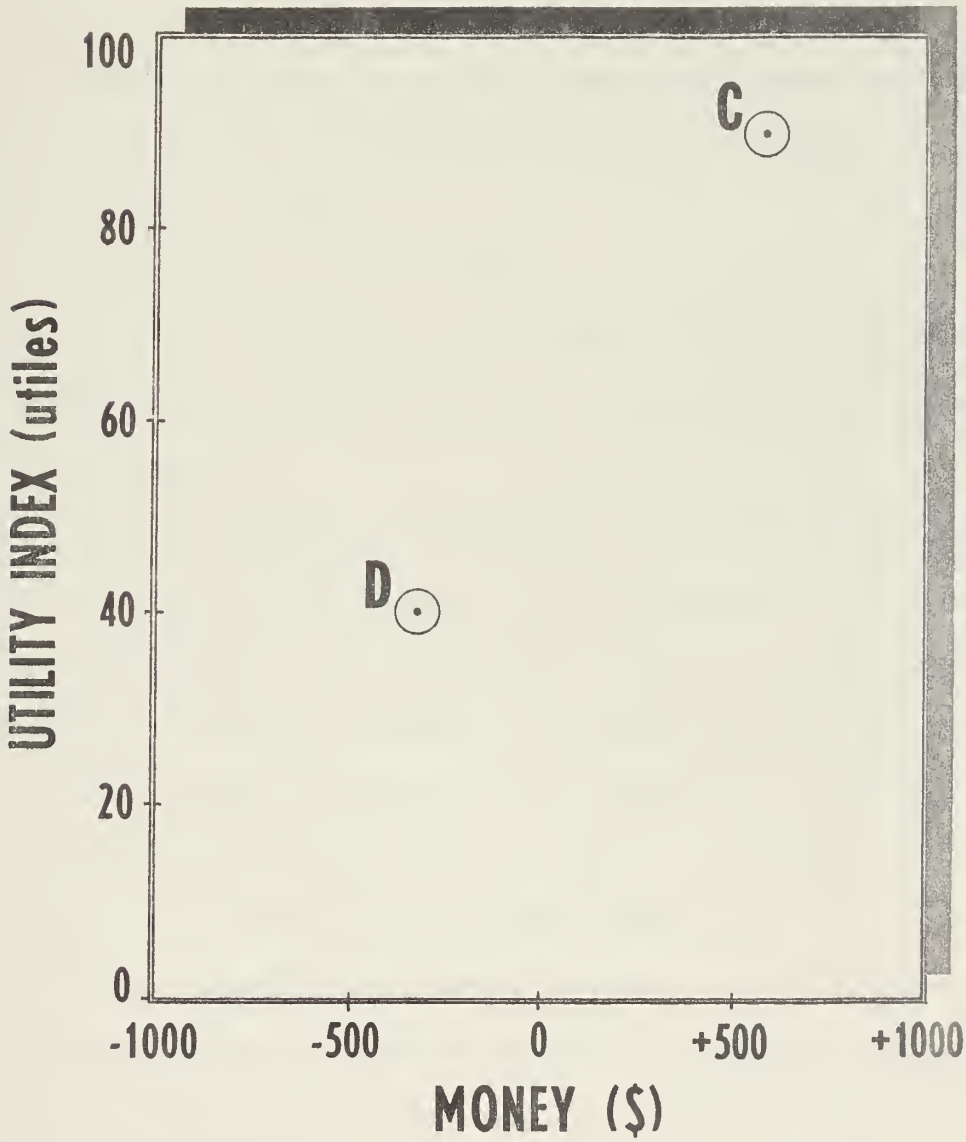

FIGURE 1 - AN ILLUSTRATION OF A UTILITY CURVE

$600 as the point of indifference a point on the utility function may be calculated as follows:

$$.90\ (100 \text{ utiles}) + .10\ (0 \text{ utiles}) = +\$600$$
$$90 \text{ utiles} = \$600$$

Thus we may plot point C on Figure 1 at (90 utiles, +$600). Proceeding in similar fashion quoting various other odds for the game the rest of the players utility function is traced. Point D was calculated in like fashion when it was indicated that the player was indifferent between a 40 percent chance to win $1,000 and a 60 percent chance of losing $1,000 and giving the operator of the game three hundred dollars (-$300) to avoid playing. The coordinates of Point D (40 utiles, -$300) was calculated from this equality:

$$.40\ (\$1{,}000) + .60\ (-\$1{,}000) = -\$300$$

Once a person's utility function has been calculated it is theoretically possible to predict that person's choice of alternative under various risk conditions.

Unfortunately, a plethora of problems confront this approach in practice. It is impractical to determine a utility function for a group, either the decision-makers or the stockholders. While for convenience the firm is spoken of as having attitudes, attitudes are held only by individuals. At present these attitudes cannot be measured or predicted accurately and even if quantification were possible the attitude of a group does not equate to the sum of the parts.[1] Moreover, even an individual's attitudes toward risk may change from day to day particularly as his cash position varies. It must also be kept in mind that the utility index is an arbitrary scale and as such cannot be compared to other persons functions. Even within a function it must be recognized that the

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[1]S. W. Steinkamp, Capital Investments and Influencing Factors, Dissertation for the University of Michigan (Ann Arbor: By the author, 1958) p. 21.

values are relative values, that is a value of 40 utiles is not twice the value of 20 utiles. An examination of the ordinary temperature scales will illustrate this point. 32°F. and 0°C. have been arbitrarily assigned as the freezing point of water and 212°F. and 100°C. as the boiling point of water. It cannot logically be said that 80°F. is twice as hot as 40°F., for if transposed to the Centigrade scale, these same temperatures are described as about 27°C and 4.5°C.[1] While the use of utility indices have thus far been of little practical use, "the concept is of more than academic use, however, since (a) it may find future use, and (b) because of the general problems exposed by discussion of the concept."[2]

In summary, utility represents an attempt to convert dollar values in a risk situation into figures which are a more meaningful description of the true value to the decision maker. While it is recognized that actual decisions are made within this context, there has evolved neither a practical quantitative procedure for applying the basic concept nor of converting these figures into a valid modification of the discount rate to compensate for risk. With respect to expected monetary value and utility, "the state of the art is such that foolproof procedures for dealing with uncertainty do not exist, but hopefully knowledge of the problems involved will forestall errors of reasoning, if not of judgment.[3] This section of the study has presented some of the basic elements underlying adjustments for risk. Their implications as applied to evaluation procedures and the discount rate are addressed in Chapter IV.

Classification of Proposals

Clearly no single scheme of classification will be equally valid

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[1]Swalm, op. cit., p. 125.

[2]Robichek and Myers, op. cit., p. 72.

[3]Ibid, p. 79.

for all uses or for all companies. The essential task is to develop a classification system for investments that is appropriate to the activity of the business and the organizational structure of the particular company.[1]

There is a multitude of ways in which proposals could be categorized. For example, they could be classified by risk level, dollar outlay required, product, lifespan, non-monetary resource requirements and many more. Some of these traits may be peculiar to some industries only. Previous reference has been made to the dichotomy of mutually exclusive and competitive proposals and there are some other categories sufficiently critical to warrant more than cursory examination.

Profit-maintaining versus Profit-augmenting

Profit maintaining proposals include replacement of existing assets which will no longer function, improvement of existing assets to circumvent competition, and provision of new facilities which were inadvertently omitted when the original facilities were installed but which are now required. Profit-augmenting proposals include the provision of assets which will increase profit by providing new businesses or by expanding existing facilities, improving product quality resulting in greater margins, or providing assets which will reduct production costs.[2]

There are at least two reasons why these categories should be differentiated. The first consideration is that owing to experience the risks involved in profit-maintenance are likely to be less than those incident to a profit-augmentation venture. The second aspect of this classification is that it initiates closer examination of capitalized replacements than might otherwise be the case. An example may serve to illustrate this advantage.

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[1]Bierman and Smidt, op. cit., p. 75.

[2]Reul, op. cit., p. 119.

A pumping station integral to a pipeline breaks down and will cost $5,000 to replace. The option of not replacing the station will result in lost revenues of $10,000. Upon this justification a new station is approved but the following year another pumping station or a section of pipe fails. A complete replacement of the system or some other alternative might have been overlooked as the initial solution. Establishment of a separate category will focus attention on a systems approach and generate more viable proposals.

Separations for Diversification

Corporations may choose to diversify for the same reasons which motivate individual investors to adopt a broad portfolio, to hedge against the unforeseen, perhaps very improbable, but always possible failure of one pillar of the financial structure. In so doing, the firm recognizes that it is usually foregoing margin of profit in return for some measure of corporate security. When a company has taken this step of diversifying it is apparent that the separate entities, be they services, products, or whatever do not necessarily harbor the same profit margin aspirations. In this environment these distinct levels of aspiration must be recognized and accounted for in the analysis process or the richer divisions will siphon off all capital investment funds. This is not to say that the opportunity costs incurred in such an arrangement should be ignored. On the contrary the process should identify these foregone profits but checks in the system should ensure that the diversification policy, once established, is not over-ridden by the mechanics of the selection procedure.

Independent versus Dependent

A proposal is economically independent of a second proposal if the benefits to be derived from the first project would remain unchanged

whether or not the second proposal is implemented. It should be clear that when an investment is dependent upon another, some attention should be given to the question of whether decisions about the first investment should, or even can, be made separately from decisions concerning the second. Questions such as this should ordinarily be answered during the formulation of the projects. Nonetheless, the possibility of this type of error should be guarded against throughout the procedure.

Cash Flow

Previously cited examples have contained cash inflows and outflows for various years during the economic lives of the proposals under consideration. It is appropriate to discuss in further detail the determination of which sums should be considered in assessment by the discount methods of analysis.

Cash flow as used in capital budgeting is a different concept than is the cash flow concept used in security analysis. In capital budgeting, cash flow should mean changes in the cash account (balance) which will result from the proposed investment.[1] The cash flows are not identical with profits or income but are the actual incremental changes in the cash balance attributable solely to the project.

In addition to being consistent with the time value of money which lies at the core of the discounting methods, the use of cash flows avoids numerous difficulties associated with the accrual method of accounting. These problems include:

1. The period during which revenue and expenditures should be recognized.

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[1]Robert K. Jaedicke and Robert T. Sprouse, Accounting Flows: Income, Funds, and Cash (Englewood Cliffs, N. J. : Prentice-Hall, 1965). p. 131.

2. Which expenses should be considered investments and therefore as capitalized items?

3. Which depreciation method should be used?

4. What method of measuring inventory flow should be used?

5. What costs should be included in the valuation of inventory?[1]

Because we are interested in the amount and timing of the incremental cash flows rather than in the conventional cost of the investment, it becomes mandatory to consider factors such as economic life, residual values, taxes, tax shields, exclusion of sunk costs, and the importance of considering all alternative uses of the assets involved.

Economic life is defined as that period over which benefits will be derived from the project. This concept is more difficult to describe than is recognizing the terminal point in practice, and it is still more difficult to predict prior to the commencement of the investment. There are three conditions which limit the economic life of a project:

1. Physical

2. Technical

3. Market

Some assets simply wear out and require retirement or the cost of repairs becomes so large that replacement is the optimal solution. This is the connotation of physical life. Technical life refers to that period of time which elapses before another machine or product renders the asset obsolescent. Market life applies mainly to products and refers to the period during which that product has profit making potentiality. Residual values include the net salvage value of the asset at the conclu-

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[1]Bierman and Smidt, op. cit., p. 107.

sion of its economic life. The residual value of items being replaced and any funds released by the conclusion of either project must be considered. The net value may be negative if removal and restoration costs are predominant.

Taxes are accounted for at the time the disbursements are made. The cash flows discounted are those net of tax shields and include the effects of depreciation allowances and investment credits. Deductions for depreciation are based on the depreciation method used by the firm for tax purposes.

Decisions made now can affect only what will happen in the future. It follows that the only relevant cost figures are estimates of costs in the future.[1] Accordingly, past, or sunk costs, are excluded from the analysis. Similarly, since our intent is to include only costs associated with the project it is important that those costs be estimated on a differential basis. This statement implies that all alternatives must be considered and involves one aspect of opportunity costs. For example, if a new process will occupy a presently vacant portion of a plant then only the additional costs incurred should be considered. Similarly, the costs associated with an alternate use of this space must be evaluated.

Due regard must also be given to insuring that cash flows are not confused with changes in working capital.[2] A project requiring a build-up of safety stock in inventory illustrates this danger. A cash outlay is involved whereas no change is evident in net working capital.

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[1]Robert N. Anthony, Management Accounting (Homewood, Illinois: Irwin, Inc., 1964), p. 566.

[2]Jaedicke and Sprouse, op. cit., pp. 131-132.

As a result, the rate of return in cash flow analysis will be lower. Failure to consider changes in investment in inventory or in accounts receivable will overstate the true rate of return. The importance of giving adequate attention to this area cannot be overemphasized for cash flows are the stuff of which dividends are made.[1]

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[1]Porterfield, op. cit., p. 32.

CHAPTER IV

RECOMMENDED APPROACHES FOR THE ESTABLISHMENT AND APPLICATION OF THE DISCOUNT RATE

The introductory chapter referred to decisions regarding the proper balance between consumption and investment, between dividends and retained earnings, between debt and equity, and between low-risk low-income projects and high-risk projects offering lucrative returns as the core of financial decision-making. Chapter II described a number of methods used in evaluating investment proposals and also examined some of the factors bearing on the investment decision. Additionally, the rationale presented in Chapter II, demonstrated not only that the discounted methods are advantageous but that they are indispensible in the process of attaining a rational evaluation of investment proprosals. Having accepted that discounting is a sine qua non of the capital investment analysis procedure, it becomes mandatory for a firm to determine a quantitative discount rate or rates.

Establishment of the Discount Rate

For purposes of this discussion, the decision concerning present consumption versus investment has already been made; it is assumed that a certain amount of funds is available for investment purposes from the capital pool of the firm. Moreover, since projects are ordinarily fi-

nanced from this pool the capital structure of the company has been predetermined. We may reason that even if "separate" financing is employed for a particular large project the terms of this financing reflect the initial capital structure and, in fact, merely alter the composite capital cost rate because such a venture necessarily affects the future capacity of the firm to raise additional capital. Therefore, the evaluation process, while not directly concerned with either determining the amount available for investment or the particular capital structure which dictates cost of capital, must necessarily take these existing conditions into account. This is done by approving projects to the point where their cumulative sum equals the funds available and by reflecting the cost of capital in the discount rate applied.

At this juncture it is appropriate to return to our discussion regarding the relative merits of the net present value and yield methods. It should be recalled that the discount rate selected in the yield method is used as a standard of comparison with that rate which equates the cash inflows to the cash outflows. In the present value method the selected rate is applied to the inflows and outflows and the net present value of the project is calculated in this fashion. Since one of the considerations in this chapter will be the rate at which recaptured capital is reinvested, future discussion will be concerned with the net present value method.

The evaluation method to be used and some of the factors to be considered have been reviewed. Essentially, the decision-maker wants to know whether or not the project under consideration will be profitable (or at least break even), the profitability of the project relative to other proposals, the opportunity costs, if any, and the uncertainties

attendant to the data presented.

These, then, are the basic considerations in the establishment of the discount rate:

a. Should the rate reflect cost of capital?

b. Should a factor for opportunity costs be added to cost of capital?

c. Should a factor to compensate for estimated risk level be added to either (a) or (b)?

Cost of Capital as the Discount Rate

There is no controversy in the literature or in industry regarding the inclusion of cost of capital in the discount rate. The cost of capital thus applied, serving as a minimum rate of return, effects a hurdle or cut-off point to keep a company from making investments which will not recover the carrying costs.[1] However, we have seen that while this approach may be theoretically correct for accept-or-reject decisions it may prove misleading when the net present value magnitudes are used for ranking competitive projects.

It should also be noted that the use of a rate based solely on cost of capital is theoretically correct only under conditions of certainty. All of the projects approved may have positive net present values but the failure of just one of the individual projects could pull the collective earnings below the breakeven point. The likelihood of such an occurence is enhanced when the combination of probabilities is considered. The combination of low probabilities must be guarded against.[2] It must be kept

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[1]Victor H. Brown, "Rate of Return," The Accounting Review (January 1961), p. 28.

[2]Ibid, p. 21.

in mind that if three projects, each possessing a .70 probability for success are approved, then the probability of all three projects being successful is only .343.

Recognition of these facts has led some authors to recommend increasing the rate to compensate for the occasional project which does not perform to expectations. This increase is considered justified since:

a. Not all capital projects are undertaken to produce profit.
b. Of those that are, some will fail.[1]

The first reason cited must result in a subjective estimate since it is all but impossible to predetermine, the effect of non-profit oriented projects upon the composite rate. The second reason can be based partially upon past performance but this figure must also be adjusted subjectively to account for future failures. It is recognized that failures will be encountered and that there is, therefore, some validity to the points cited above. These facts must be taken into account but it remains to be seen if the discount rate is the vehicle to reflect their presence.

Some advantage is to be gained from the use of a "pure" cost of capital rate because it does reflect the capital structure of the firm. Moreover, it is a figure which is recognizable and understandable to the evaluation panel. Addition of other factors to the cost of capital will obscure its basic advantages of providing an accept or reject datum, an easily understood value and, perhaps more importantly, the only figure which may be applied to ALL projects as a common denominator will have been lost.

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[1]National Industrial Conference Board, Research Report #107, Capital Expenditures (New York: March, 1963), p. 150.

It is well to note at this point that a cut-off rate should not be absolute since other attributes of a proposal may well justify its approval. There is the distinct danger that an approved guideline all too frequently is perceived as a hard and fast rule with effects far and beyond its original intent. In the interest of achieving rational examination of all proposals, it should be emphasized that the criterion should be treated as guidelines and not as absolute barriers. Increasing the discount rate beyond the cost of capital increases the danger that more projects with merit will be overlooked.

A persistently high cut-off rate means that productive facilities may be kept too long with resultant excessive operating costs. Companies in such a position are handicapped in competition with others able to reduce their operating costs by carrying investment down to a lower exclusion level.[1]

These are some of the disadvantages of raising the discount rate above the cost of capital. As for the cost of capital, itself, there is no doubt that it should be the minimum rate applied and should form the foundation upon which surcharges for opportunity costs and risk level may be added.

Cost of Capital Plus Opportunity Cost Surcharge

The discount rate may be raised above the explicit, or composite, cost of capital in an attempt to account for the implicit, or opportunity, cost of capital. These foregone profits may be the result of passing up other investment opportunities either internal or external to the firm.

If the firm were to follow this course the disadvantages previously enumerated would be encountered. Furthermore, to be effective and consis-

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[1]George W. Terbough, Business Investment Policy - A MAPI Study and Manual (Baltimore: Lord Baltimore Press, 1968), p. 203.

tent the highest possible return would be applied against all proposals. This would be so even if the amount which could be invested at this rate were less than the total available for capital investment. If this is the case then this higher rate is certainly prejudicial against some projects. It is not practical to apply the highest rate against all projects.

Additionally, it is impractical to apply the highest rate to only a portion of the proposals at hand for how is this portion to be selected? Even if this hurdle could be overcome, comparability of all proposals has been lost.

The only advantage of including implicit costs in the calculation is that it may focus attention on various extremely profitable opportunities, particularly on those external to the firm. It is doubtful that these opportunities will go unrecognized in any case if the system for generation of proposals is performing as it should.

In a firm with diversified product or service divisions the application of a uniform opportunity cost possesses additional disadvantages. The basic decision to diversify may have resulted from a requirement to provide a full product line, to achieve flexibility or from other reasons such as simply to hedge against a failure or abrupt marketing change in a major segment of the firm's activities. For a firm with a diversified structure what contribution does the opportunity rate make? All investment proposals will ordinarily be financed from the composite pool and the cost of capital, explicit to the firm, both explicit and implicit to the individual investor, is determined by the composite posture of the firm and not by any one service or any one product.

The decision to diversify inherently involved a recognition of different profit aspirations. The application of a uniform opportunity

rate, and to be of use it must be uniform, does not contribute to the evaluation and allocation process and may, in fact, be deleterious. It can result in the starvation of divisions with low profits and a continued buildup, perhaps to the point of overexpansion, of "fat" divisions.[1]

A Rate Including a Premium for Risk

Risk and uncertainty are the inevitable concomitants of many forms of investment and investment appraisal techniques which cannot be adapted to this state of affairs are likely to be of little practical use. Risk in particular capital budgeting decisions generally derives from the following five sources:

(1) Insufficient data regarding similar investments.

(2) Misinterpretation of data.

(3) Bias in the data and in its assessment.

(4) Change in the external economic environment which invalidates much of the usefulness of past experience.

(5) Errors in analysis.

The final source of risk includes errors of financial analysis.[2]

To be of assistance to the decision-makers it is important that the evaluation method include some indication of the level of risk involved in the undertaking of a proposal. A number of authorities argue that a premium for risk should be added to the cost of capital discount rate. For example,

Dean states:

> "A rejection rate higher than the cost of capital is needed for projects because all are riskier than the past

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[1] Ibid, p. 204.

[2] Merrett and Sykes, op. cit., p. 176.

average and some are riskier than others."[1]

Some proponents of a risk premium refine their approach by assigning different premiums to different categories of projects. At the opposite extreme, other authorities contend that a risk premium, contained in the discount rate, is incorrect and that the risk attendant to a project should be indicated in some other fashion.

The advantages of a higher rate, to provide a margin for error and as a technique for connoting different risk situations, have been noted. Besides the general drawback of a high rate tending to exclude projects which may have merit, what are some of the other objections to a risk premium?

The most important objection is based upon the function of risk through the economic life of the project. Due to the nature of discounting we may apply some constant surcharge to the rate to provide an indication of risk, if and only if, the risk of expected returns increases at a constant rate as a function of the time at which the returns are expected to be achieved.[2] However, in practice, this assumption would be correct only in a small number of cases.

With uncertain cash flows, except in these special cases, adding a risk discount to the time value discount rate does not incorporate any consideration of the value of information arising from differences in time at which uncertainty about the magnitude of the cash flows will be

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[1]Joel Dean, "Controls for Capital Expenditures," American Management Association Financial Management Series (No. 105, 1953), p. 11.

[2]Robichek and Myers, op. cit., p. 84.

eliminated, does not reflect any information that may be available about the correlation between the returns of the other business operations in a particular firm, and does not incorporate attitudes towards risk into the evaluation of an investment proposal in an effective manner.[1]

The other objection which may be cited regards the application of the risk premium to cash inflows and cash outflows alike. While it may be justifiable to discount income because of risk aversion it is rarely justifiable to discount cost for the same reason. A cost to which some certainty attaches represents to an individual with risk aversion a heavier burden than a cost of the same magnitude to be incurred with certainty.[2] Thus, a cost of this nature should be inflated rather than "discounted."

It is sometimes noted that the cost of capital rate already contains an implicit cost of risk on the part of the investors. While this is undoubtably so, this composite cost is a function of the condition of the firm, in aggregate, and no attempt should be made to estimate its variability for individual projects financed from the firm's general fund.

Quite obviously a method which incorporated the cumulative advantages and eliminated some or all of the disadvantages would be more effective. An attempt shall now be made to describe a method which together with other data would provide the decision-makers an objective useful anatomy of a project.

A Recommendation for Profitability Index

The presentation of a proposal should provide visibility of the

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[1]Bierman and Smidt, op. cit., p. 325.

[2]V. L. Broussalian, On Discounting Risk in Military Investment Decisions (Washington, D. C.: The Franklin Institute, 1966), p. 9.

resources involved, the economic life, sensitivity as related to the critical factors affecting risk and profitability. It is considered that a modification of the Profitability Index could accomplish these purposes.

It will be recalled that the Profitability Index is calculated by dividing the present value of cash inflows with the present value of cash outflows. If the cost of capital rate were applied, a summary presents to the reader the cost of resources consumed, the length of time involved, the returns anticipated, and a viable indication of return on investment. Using the cost of capital rate provides better visibility of the basic carrying costs and is a factor common to all proposals irregardless of the type of project or level of risk involved.

Moreover, opportunity cost or a target return on investment is more easily and more practically reflected in a Profitability Index standard than through a portion of an aggregate discount rate. A target of this type can be adjusted by experience and inevitable subjectiveness for different risk categories and, in addition, lends itself well to varying standards for different profit aspirations of diversified divisions.

In most cases, a single factor may be indentified as being critical to the success of the project. There is no doubt that a sensitivity analysis should be performed to establish and communicate the acceptable perimeters of the critical factor. Identification of the critical factor is crucial for the collective utility function, as yet unmeasurable, of the evaluation board applied to this factor will probably determine the fate of the proposal.

Applications of the Discount Rate

Having discussed the establishment of the discount rate, it is

appropriate to examine the applications of that rate. The use of the discount rate in present value analysis has been addressed earlier in this study and will not be reviewed but two controversies regarding refinements of the discount rate application remain to be investigated. These are the choice between a single or multiple discount rate approach and the choice between periodic or continuous discounting. The use of a discount rate in the "smoothing" of non-uniform cash flows for use in the comparison of proposals having different economic lives and determining the cost of postponing a project in anticipation of subsequent higher returns will also be demonstrated. It is noted that these latter applications are not integral to the discounting methods of analysis discussed heretofore, but rather are special applications of discounting to facilitate singular calculations.

Single versus Multiple Discount Rates

The usual present value procedure involves the application of a single discount rate to all cash inflows and outflows. The application of a single rate is also inherent in the yield method.

The literature contains another approach which contends that while the above procedure is convenient, it ignores the fact that the cash inflows actually serve two purposes and therefore require a separation into that portion which represents the recapture of committed capital and into that portion which represents the true income generated by the execution of the proposal. From this nucleous proponents of the multiple rate approach expand their rationale, initially by stating that in most instances the rate of return envisioned for the project under scrutiny is not identical with the average rate of return which the firm is realizing on its total capital investments.

In only a minority of cases will capital be obtained by the float-

ing of a debenture or the issuance of stock for the purpose of funding a specific investment proposal. In the preponderance of cases the project will be funded from the firm's general pool of capital resources. Furthermore, as that portion of the cash inflows required for replenishment of capital is recaptured, it is returned to the central pool and reinvested. The distinction drawn by proponents of a multiple rate approach is that once funds are returned to the general pool this capital ceases to aggrandize at the rate of the particular project but instead does so at the average rate at which general corporate funds are being invested.[1] It is, therefore, illogical and erroneous to apply the individual project rate to all cash inflows. It follows that the magnitude of the miscalculation will depend upon the variance between the average and project earnings rates and upon the ratio of cash inflows which are reinvested to those used for other purposes. To correct these supposed errors it has been recommended that one discount rate be applied to original project investments and a different discount rate applied to reinvested flows.

The dual or multiple rate approach is considered by this writer to have significant conceptual merit but to be questionable and administratively burdensome in practical application. It presupposes that meaningful costs have been established for various financing sources and different discount rates established for various projects. Moreover, this approach makes mandatory the accurate prediction of the rates of return at which cash inflows from the individual proposals will be reinvested and the time at which such reinvestments will occur. Excessive calculations and substitutions may be pursued beyond that point in time where

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[1]Robert H. Baldwin, "How to Assess Investment Proposals", The Harvard Business Review (May-June, 1959), p. 97.

differences are significant and the plethora of discount rates which may be established would cause an attendant myriad of instructions and procedures regarding their application.

More importantly, the foundations of this approach are at variance with the previous conclusions reached concerning the advantages of utilizing one discount rate based solely on the composite cost of capital. Since the majority of adjustments contemplated under a multiple rate approach are compensated for in the Profitability Index Method recommended previously, a single discount rate[1] is considered more advantageous than multiple rates.

Continuous versus Periodic Discounting

It is generally accepted practice to use periodic, usually annual, discounting tables although it is recognized that some projects realize their cash inflows on a continuous basis, or at least on a more frequent incremental basis than is reflected in the use of annual tables. There is disagreement in the literature regarding how this apparent disparity should be reconciled. For example Ravenscroft states:

"These continuous flows of income or investment can be more correctly handled by using discount tables based on continuously compounded interest."[2]

while Merrett and Sykes choose under all but extreme circumstances to use annual tables:

"We recommend using only annual discounting unless special circumstances justify a shorter interval."[3]

It is recognized that the use of continuous discounting produces

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[1]By single discount rate this writer intends a rate which would be unchanged by varying profit and risk potentials. Alterations in projected cost of capital would require adjustment.

[2]Edward A. Ravenscroft, "Return on Investment", The Harvard Business Review (March-April, 1960), p. 100.

[3]Merrett and Sykes, op. cit., p. 28.

evaluations that are slightly, but consistently, conservative.[1] Nevertheless, this writer considers the choice between periodic and continuous discounting dependent upon the particular nature of the firm and the type of investment being considered. A decision which affects rapid turnover of inventory requires treatment distinct from a manufacturing plant involving a single annual lease payment. Thus no one choice is conceptually correct and the determination must be largely situational.

However, since this study is primarily concerned with investments of a plant account nature some additional comments regarding this area are germane. It is considered that periodic compounding would be more appropriate in the majority of cases because of:

1. The influence of significant incremental impacts of tax payments, investment credits, and depreciation entries.

2. The relative improbability that inflows are reinvested on a continuous basis.

3. The maintenance of relativity and comparability and the reduction of any discrepancy since either type of rate would be applied to cash inflows and outflows alike.

The Smoothing of Cash Flows

In order to demonstrate a technique for smoothing a non-uniform cash flow the data in Table 9 and a discount rate of ten percent will be assumed.[2]

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[1]Reul, op. cit., p.121.

[2]A discount rate of 10% will be used for all calculations in this chapter. The examples and calculations are patterned after the presentation by Pierson Hunt, Financial Analysis in Capital Budgeting (Boston: Graduate School of Business Administration, Harvard University, 1964).

TABLE 9

SMOOTHING NON-UNIFORM CASH FLOWS

Year	Amount ($)	Factor	Product
1	10	.909	9.090
2	8	.826	6.608
3	6	.751	4.506
4	4	.683	2.732
5	2	.621	1.242
Total		3.790	24.178

The total present value may be spread over the five year period and that annual dollar amount which equates to the non-uniform cash flow may be calculated by applying the capital recovery factor which for a five year period at a discount rate of ten percent is 0.264. The equivalent annual flow for the example equals (.264) ($24.18) or $6.38.

Comparison of Annuities with Different Life Spans

The smoothing technique demonstrated above permits a comparison between projects having different returns and lives. Assume a choice exists between Project A which will provide an annual return of 30% for seven years and Project B which offers a 20% return for twelve years. The income of an average investment during years 8 through 12 is estimated at 10%. The resultant flows are contained in Table 10.

The calculations for the smoothed ROI of Project A are:

$$(30)\ (3.605) = 108.15$$
$$(10)\ (4.439-3.605) = 8.34$$

$$\frac{108.15 + 8.34}{4.439} = 26.24$$

and, on the basis of rate of return, Project A is preferable.

TABLE 10

COMPARING PROJECTS OF DIFFERENT LIFE SPANS

Year	ROI Project A	ROI (smoothed) Project A	ROI Project B
1	30	26.24	20
2	30	26.24	20
3	30	26.24	20
4	30	26.24	20
5	30	26.24	20
6	30	26.24	20
7	30	26.24	20
8	10	26.24	20
9	10	26.24	20
10	10	26.24	20
11	10	26.24	20
12	10	26.24	20

Calculating the Consequences of Postponement

A similar discounting technique may be used to calculate the cost of delaying the initiation of a project. Assume that the opportunity exists to make an investment which will provide an income of 6% for 12 years. An income of 3% can be earned on capital during the period of contemplated postponement. Circumstances dictate that the project be started now or postponed for six years and therefore the alternate flows are as depicted in Table 11.

The present value of an annuity of 6% for 12 years is 50.30 and the present value of 3% per annum for 6 years is 14.75. The question of what income must be produced by the project during years 7 through 12 if

total return is to be equivalent to starting the project immediately may be calculated as follows:

Present Value of Income required for years 7 through 12 = 50.30 - 14.75 = 35.55.

x = the annual annuity during years 7 through 12 which equates to a present value of 35.55. Using the smoothing technique previously demonstrated a value of x = 10.26 is calculated. Therefore, if the project will not return at least 10.26% during years 7 through 12 it should not be postponed.

TABLE 11

EFFECTS CAUSED BY POSTPONEMENT OF A PROPOSAL

Year	ROI (start now)	ROI (start in year 7)
1	6	3
2	6	3
3	6	3
4	6	3
5	6	3
6	6	3
7	6	x
8	6	x
9	6	x
10	6	x
11	6	x
12	6	x

CHAPTER V

CONCLUSIONS

In the introductory chapter the basic research question and a number of incremental subsidiary questions were raised. A restatement of the queries and a recapitulation of the comments presented in the intermediate chapters constitute the framework for this summation. The basic research question posed was:

What are the factors which should be considered in the establishment of the discount rate utilized in the discounted-cash-flow methods of evaluating capital investment proposals?

To orient the approach taken toward answering this question the primary objective of the firm, maximizing the wealth of the owners, and a description of capital investment evaluation techniques were presented in Chapter II. It was established that a method to be conceptually correct and of practical significance had to take into account the time value of money and the cash flows incident to the project under consideration. The Net Present Value and Yield techniques were selected as viable procedures and their relative advantages and limitations were discussed.

Having concluded that the utilization of a discounted cash flow analysis was mandatory the factors bearing on the eventual determination of the discount rate were examined. Thus Chapter III. presented a discussion of capital structure, cost of capital, classification of projects,

cash flows and risk. It was recognized that all of these factors affected proposal evaluation and that the cost of capital, a factor to compensate for risk and a factor to account for opportunity cost could well be incorporated directly into the discount rate.

Chapter IV. delineated the advantages and disadvantages which would accrue by establishing a discount rate based upon:

1. The cost of capital only.
2. The cost of capital plus a factor to compensate for risk.
3. The cost of capital plus a factor to account for opportunity cost.
4. The cost of capital plus factors for both risk and opportunity cost.

In the interest of preserving a meaningful figure which was applicable to all proposals and to avoid the elimination of worthwhile projects while maintaining an accept-or-reject datum the use of a single discount rate based on cost of capital was recommended. To attain a practical procedure for recognizing various risk levels and diverse profit aspirations the use of this single discount rate within the context of a Profitability Index technique utilizing different indices for different classifications of proposals and for different diversified operations was proposed.

Chapter IV. also examined the application of multiple discount rates as opposed to the use of a single discount rate throughout the estimated useful life of the proposal. It was recognized that changes in the cost of capital might well require a change in the discount rate but the use of a discount rate based on the cost of the corporate capital pool obviated the necessity for utilizing two discount rates, one for the re-

turn peculiar to the individual project and one equating to the cost of maintaining the central capital pool.

The question of periodic versus continuous discounting was then addressed and it was concluded that neither was exclusively correct on a conceptual basis but rather that the proper choice was dependent upon situational factors. Due to the influence of incremental receivables and disbursements augmented by the effects of tax considerations it was concluded that for investments of a plant account nature periodic discounting is more frequently appropriate.

The conclusions reached with respect to the incremental questions raised can thus be stated as follows:

1. Should the discount rate be based principally on the cost of capital?

Conclusion Number One - the discount rate should be not only based upon the cost of capital but should equate to the cost of capital.

2. Should the discount rate include a factor to compensate for risk?

Conclusion Number Two - the discount rate should not include a factor to compensate for risk. Varying risk levels should be recognized by the establishment of diverse profitability indices.

3. Should an identical discount rate be applied to all proposed projects in a given corporation?

Conclusion Number Three - a single discount rate based on the cost of capital should be applied to all proposed projects in a given corporation. However, various project groupings and different profit aspirations may be recognized by introducing different profitability indices.

4. Should the discount rate remain constant as applied to all cash inflows and outflows throughout the estimated useful life of the project?

Conclusion Number Four - the discount rate should remain constant unless a change in the composite cost of capital is forecast.

5. Should periodic as opposed to continuous discounting be used for all projects?

Conclusion Number Five - neither continuous nor periodic discounting is exclusively correct on a conceptual basis and the choice of method is dependent upon situational factors. However, the influence of incremental receivables and disbursements and the impact of tax considerations dictate that periodic discounting is more appropriate for proposals involving plant account transactions.

It is concluded that, within the context of the objectives of the firm, the factors examined in Chapter III and reiterated in this chapter must be elicited and scrutinized during the evaluation process. The discount rate utilized in the method of analysis should be based solely on the firm's cost of capital. Other factors such as level of risk and opportunity cost are reflected more advantageously by other vehicles, preferably by differentiated levels of acceptance of the Profitability Index.

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